



Distribution Vegetation Management Strategies

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Strategy Statement

The intent of this written strategy document is to outline all the procedures used to manage the distribution circuit pruning program and the distribution hazard tree program currently in practice. These are reliability-focused strategies designed to meet both state regulatory targets and support first quartile reliability performance. In addition, cycle pruning provides a measure of public safety by minimizing the potential for public contact with energized conductors through tree climbing as well as the potential for electrically caused fire in trees.

This work is expected to reduce the National Grid upstate New York SAIFI by 0.023 annually, Massachusetts by 0.057, Rhode Island by 0.028 and New Hampshire by 0.226 assuming the same level of funding each year. This improvement is based on a reduction in the number and magnitude of vegetation related interruptions by establishing, maintaining, or in some cases, reducing the base pruning cycle length for all distribution circuits. In addition, in the case of the distribution hazard tree program, the improvement is based on a reduction in the number and magnitude of vegetation related interruptions on the sections of distribution circuits where this is employed.

These two programs (circuit pruning and hazard tree removal) together under the title of Incremental Vegetation Management are one of the four major strategies designed to improve National Grid's reliability performance as measured by state regulatory service quality targets. The overall goal is to meet state regulatory targets by 2008. In addition to the regulatory targets, compliance with this strategy is demonstrated by keeping all circuits on the appropriate base cycle schedule as described in section 2.2.

The main benefits/risks are safety, reliability, regulatory and efficiency.

Amendments Record

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
1	06/04/08	Initial Issue	Craig M. Allen Vegetation Strategy	John Pettigrew Executive Vice President, Electric Distribution Operations

Strategy Justification

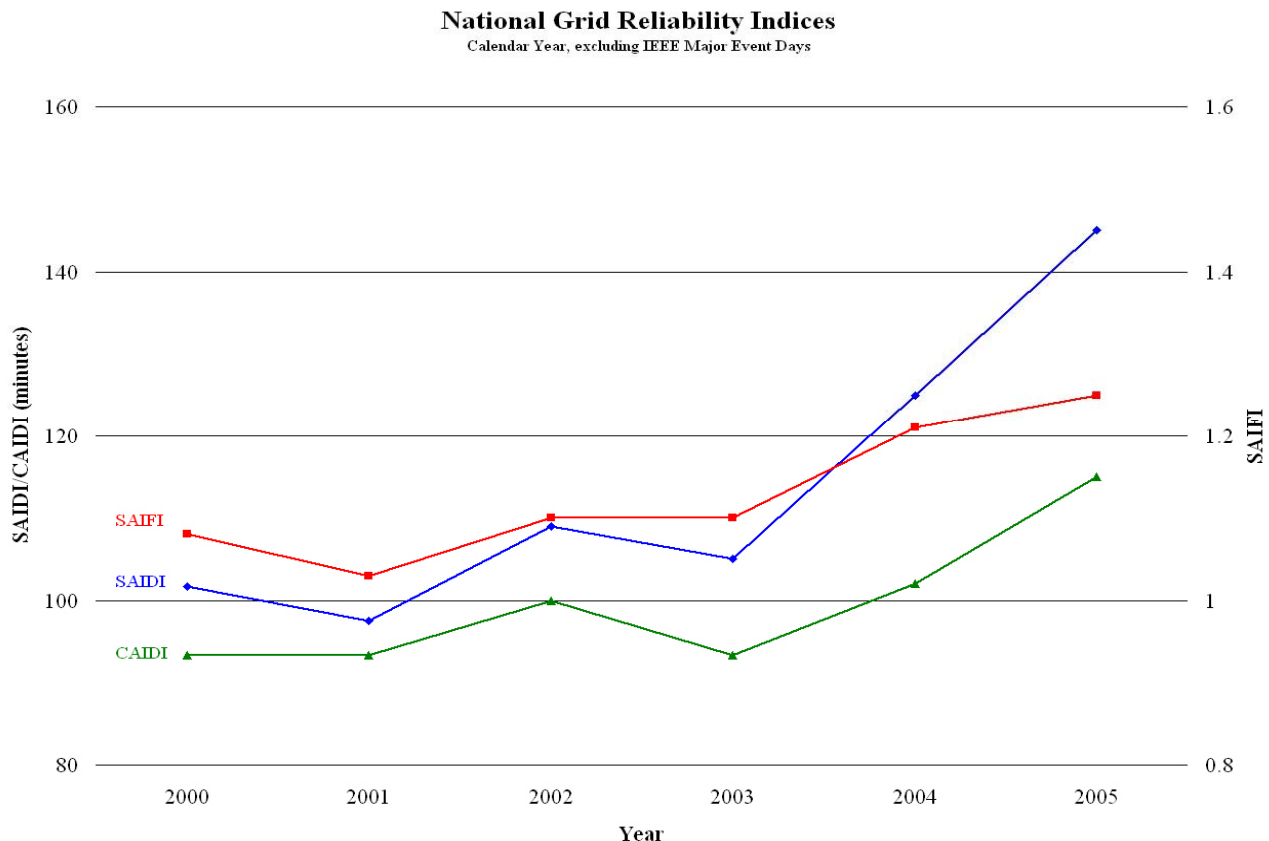
1.0 Purpose and Scope

This strategy describes a Distribution Circuit Pruning program along with an On-cycle and Off-cycle Hazard Tree removal program. The main purpose of these programs is to create and maintain clearance between energized distribution conductors and vegetation, primarily tree limbs. In addition, the hazard tree program is intended to minimize the frequency and damaging affect of large tree and large limb failures from along side and above the company's overhead primary distribution assets. This is a reliability-focused strategy designed to meet both state regulatory targets and support first quartile reliability performance. In addition, the circuit pruning program provides a measure of public safety.

2.0 Strategy Description

2.1 Background

Trees, animals, lightning and deteriorated equipment are the major drivers in National Grid's reliability performance. Since approximately 2001, the distribution reliability performance in these areas has been steadily worsening. Along with this deteriorating reliability performance, the company has been assessed steadily increasing financial penalties from state regulators due to our poor performance against the regulatory service quality targets.



The Vegetation Management program is one of the four main components of The Reliability Enhancement Program (REP).

The goal of the REP is to meet state regulatory service quality targets by 2008 and be first quartile by 2011 (IEEE North American Survey 2004).

2.2 Detailed Description and Implementation Process

Distribution Circuit Pruning: A specific base pruning cycle length has been set for all circuits by state based on the general length of the growing season as well as the growth characteristics of the predominant tree species in each area. It is important to note that stable and consistent circuit pruning program provides not only a measure of reliability improvement but also is an important aspect for maintaining public safety regarding climbable trees and tree/wire contact risks like fire. In addition, consistent circuit pruning improves line crew accessibility therefore improving restoration and maintenance efficiencies. Finally, timely circuit pruning will also enhance the accuracy and efficiency of the line inspection process.

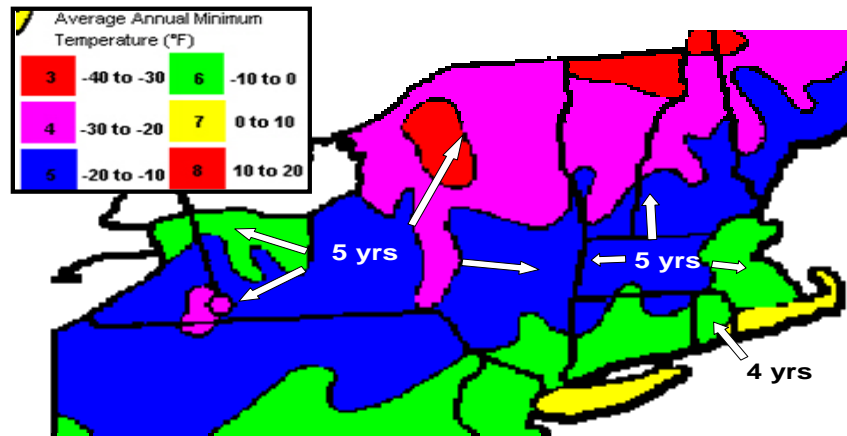
The basis for the program is the schedule or length of time determined to be optimal between pruning events on a circuit. This schedule or cycle is determined based on average growing season, the growth rates for the areas most common tree species and the clearance to be created at each pruning event. This cycle length becomes the Base Cycle Length for an area, in this case by state. It is feasible that due to variability in geographic areas, population density, public acceptance of pruning and species diversity that it may be prudent in the future to have circuits of varied cycle lengths within one state. However the average cycle length in that state would still match the base cycle length stated below. As an example, in NY there may be a population of circuits on a four year cycle, some on a five year cycle and some on a six year cycle.

Listed below are the revised base cycle lengths employed for each of the National Grid operating states.

<u>State:</u>	<u>Base Cycle Length:</u>
Massachusetts	5 years
New Hampshire	5 years
New York (Upstate)	5 years
Rhode Island	4 years

The diagram below shows Hardiness Zones delineated by the U.S. Agricultural and Markets Department. These Hardiness Zones relate directly to growing season length which forms the basis for creating the new base cycle lengths for distribution pruning as overlain on the Hardiness Zone map.

Tree Hardiness Zones – Surrogate for Growing Season vs Pruning Cycle Length



Circuit pruning is not a new program at National Grid. However the circuit pruning program has been enhanced in three ways. First, in the three New England states, all pruning was converted to a circuit-based approach rather than town or grid based. Secondly, cycle lengths were shortened to be more comparable to average growing seasons in each area. Thirdly, enhanced pruning specifications were introduced to create additional clearance, especially overhead, and to remove additional interruption hazards at the time of the pruning operation. The following paragraphs discuss each of these changes in more detail.

First of all, in the New England states the circuit pruning was being performed on a township basis. When a town came up on the schedule, every distribution line segment in that town was pruned with no regard to the actual distribution circuit configuration. This approach offered little possibility for improving vegetation related reliability performance except possibly on smaller circuits that were contained all within one town. Now all circuit pruning in all four states is performed on a circuit basis, beginning at the first span outside the station fence and continuing to the last span of primary and secondary at the end of the circuit.

Secondly, in all four states the distribution pruning program has been subject to variable levels of funding. In the New England states there had been some fairly lean budget years where the amount of funding for mileage pruning could have only produced the equivalent of an eight to nine year cycle. NY had been performing circuit based pruning on a consistent cycle for many years however experimented with lengthening the cycle as part of a major cost-cutting exercise back in the 1998/99 time frame. At that time the average circuit pruning cycle was lengthened to about six and one half years with a few rural circuits out to eight years.

The third REP enhancement to the circuit pruning program was the improvement around actual clearance dimensions and work scope or specifications. Overhead clearances requirements in the New England states have increased from six feet to ten feet overhead on maintained yard areas and up to fifteen feet of overhead clearance on un-maintained properties to equal the New York (upstate) clearances. Also, additional work scope requirements have been added to remove all

overhead dead, dying and structurally weakened limbs at the time of pruning to minimize potential interruptions from falling limbs. The actual circuit pruning specifications are included in the appendix of this strategy paper.

Circuit Pruning - Annual Circuit Selection

In Upstate NY where a cycle pruning program has existed long enough to re-cycle six times, the annual circuit pruning work plan is developed by utilizing each circuit's last pruning date plus the base cycle length for that state or area. For example, in Upstate NY where every distribution circuit has been maintained at least six times through a maintenance cycle, a circuit pruned in fiscal year 2004 be scheduled again for pruning in FY09 as NY is currently funded at a five year cycle level. In addition to scheduling each circuit by last prune date there is also an objective to bring all the circuits out of a station together for maintenance pruning on the same year. This would alleviate the problem caused by load rebalancing between circuits out of one station and the potential for portions of a circuit to be missed by the circuit pruning operation as one section of a feeder may get shifted to another feeder from the same station that has just been pruned the previous year. These shifted sections can potentially go well beyond their base maintenance cycle length in the worst case scenario before being pruned however this rarely occurs due to the field inspection work performed by the field arborists as well as National Grid's distribution inspection program.

In the three New England states where the cycle pruning program is still immature and one complete cycle has not yet been completed, the circuits are scheduled in a different manner. The annual schedule for circuit pruning is developed by using the Tree Model to rank all circuits except for those pruned in the past three years as these areas are currently beginning the fourth year of a five year cycle in the case of Massachusetts and New Hampshire, and the third year of a four year cycle in Rhode Island. This way the remaining two year's worth of un-pruned circuits are prioritized by the Tree Model so that the pruning dollars are spent in the best manner. This method has been used each year since the start of the current cycle program in the New England states. For FY10, the remaining circuits not pruned in the past four years will be ranked by the Tree Model just to create an order to schedule the year's work but in fact, all those remaining circuits will be scheduled for pruning work that year.

Using this current strategy, beginning in FY11 all four states will have completed at least one full cycle and will begin using the NY scheduling process to determine the annual cycle pruning work plan.

From time to time a district may have too many or too few miles to prune than budgeted due to past scheduling issues or circuit reconfigurations. Where circuits need to be added or removed to create a balanced annual schedule the circuit ranking from the Tree Model is utilized. The circuit rankings are utilized to guide field assessment audits to determine which circuits may need to be added or removed to balance the annual schedule while maintaining a reasonable level of tree-related reliability. The field assessment is a necessary step to ensure that actual vegetation grow-in conditions are acceptable when a circuit is being pushed out one more year. The same process is utilized for circuits that would ordinarily not be ready for pruning based on their base cycle length however the Tree Model results show poor reliability performance and the

subsequent field assessment determines that there are vegetation grow-in conditions that will make it risky to allow the circuit to go to full cycle.

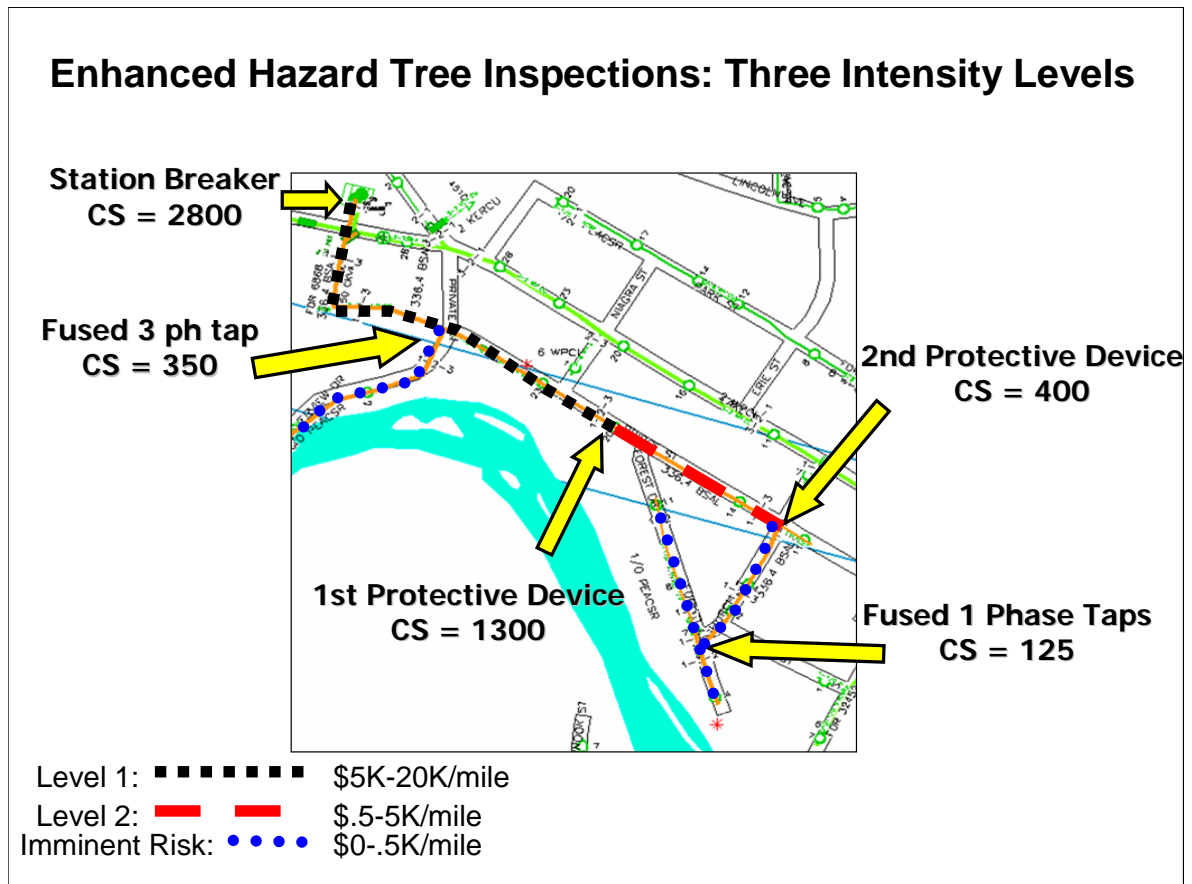
Enhanced Hazard Tree Mitigation: Full tree and large limb failures are responsible for a significant portion of National Grid's interruptions. Research done at Niagara Mohawk prior to the merger shows that over 75% of tree interruptions came from outside the pruning clearance zone. Pruning specifications have been enhanced since that study was done to include additional overhead clearances and the removal of dead, dying or structurally weakened overhead branches however the point is that the vast majority of tree interruptions still come from trees and limbs failing or breaking and falling onto the overhead conductors, not from grow-in conditions. Based on interruption data classified in the SIR system for NY or in the IDS system for NE, tree growth makes up only 4% of the interruptions in National Grid. Compare that to 57% of the Tree SAIFI that is caused by Tree Fell interruptions. This data triggered the development of a hazard tree program in New York State back in 1999. Post project data from the early NY hazard tree projects showed Tree SAIFI improvements of 67% on circuits where hazard trees had been completed. This early experience and along with benchmark information for other utilities that showed similar results for hazard tree programs at other utilities and the fact that hazard tree programs were becoming much more common place in the utility industry, spawned the current Enhanced Hazard Tree Mitigation (EHTM) Program used in all four states today.

The hazard tree program has two forms – either on-cycle or off-cycle referring to whether the circuit being worked is also undergoing circuit pruning the same year or not.

For on-cycle enhanced hazard trees a specific amount of money is budgeted each year for the three phase portions of all the circuits scheduled for maintenance pruning. The budget amounts are based on historic costs/mile experience as well as tree density per mile for each state. The budgeted amounts based on FY09 costs are as follows:

NH - \$5000 per three phase mile
RI - \$4000 per three phase mile
MA - \$4000 per three phase mile
NY - \$2500 per three phase mile

These dollars are then applied across the annual scheduled feeders based on the ranking from the Tree Model discussed in the next section of this strategy. Besides prioritizing the circuits each circuit is then partitioned into SAIFI risk segments based on the number of customers served and location of each protection device along the circuit. The hazard tree inspection work is broken down into three intensity levels corresponding to the SAIFI risk segments. The first or highest level of inspection intensity is employed all on circuit segments serving over 1500 customers. The second level of inspection is employed for circuit segments serving from 500 to 1500 customers. Finally the third level of inspection is used for segments serving less than 500 customers. The diagram below depicts the different intensity levels and the approximate amount of hazard tree spending expected to occur along each level.



After setting these hazard tree inspection levels, Vegetation Strategy reviews five years worth of tree interruption location data to locate any areas on the circuit outside of levels 1 and 2 that may show enough evidence of past poor performance to have the hazard tree inspection level elevated for those specific sections. This practice will catch any small pockets of poor performance where only a small number of customers may be served but the frequency of the tree outages is making the overall effect of these outages something that deserves more attention.

Off-cycle EHTM circuits are identified in one of three ways.

- 1) Any circuit that was identified as a poor performer using that state regulator's formula for such and so has been identified and field checked and determined to need hazard tree work to improve the reliability performance.
- 2) Any circuit, whose Tree Model ranking is below an annually determined standard based on fund levels and is not scheduled for circuit pruning based on its base cycle and field verification of the current growth conditions.
- 3) Any circuit that was identified through the Problem Identification Worksheet process and has been field checked and determined to need hazard tree work to improve the reliability performance.

Once funding is approved for the off-cycle work the same SAIFI risk segmentation approach is utilized as described above.

The enhanced hazard tree specification is included in the appendix of this document.

2.3 Tree Ranking Model

The Tree Ranking Model extracts data from the reliability source systems related specifically to tree caused interruptions. Additionally, regional IEEE 1366 Major Event Days and supply and substation related events are excluded from the analysis. This reliability data is combined with feeder asset data to create a framework to assess the performance of the feeder and determine the potential for reliability improvement through the Vegetation Management Programs.

The filtering criteria for inclusion in the model are:

- Customers Served > 0
- Number of interruption events in last three years > 1
- Total Customer Minutes Interrupted (CMI) > 500

The filters are designed to exclude only the obvious feeders which should not be selected.

A brief description of the model ranking process follows:

The Tree Model analyzes the last three calendar year interruption events related to tree related interruptions and combines this information with customer served and overhead feeder mileage data to calculate a combined ranking of all the feeders across New England/New York that meet the model filtering criteria (described above).

Four separate rankings are calculated for each feeder. A ranking of 1 in each metric represents the most desirable feeder:

- Customers Served
Ranked highest to lowest customers served
Based on the last calendar year's customers served (not a historic multi-year average)
Used to model the future value of the avoided interruption
- CMI/Event
Ranked highest to lowest CMI per event
Based on the last three years of interruption events
Used to model the historic severity of the interruption events
- Events/Mile
Ranked highest to lowest events per mile of overhead exposure
Based on the three year average interruption events and the current year's miles of overhead exposure
Used to model the historic density of the interruption events

- Dollars/Change in Customer Minutes Interrupted (\$/ΔCMI)
Ranked lowest to highest \$/ CMI
Based on the three year average ΔCMI assuming a fixed improvement percentage and a fixed cost per mile to mitigate the interruptions
The lower the \$/ΔCMI, the more cost effective the mitigation
- The above four ranks are combined (and sorted low to high) as follows:
 - Overall Rank = Customer Served Rank + CMI/Event Rank + Events/Mile Rank + \$/ CMI Rank

Feeders are initially selected for each company and district or region of National Grid based on the budgets established in the cycle set for each state. These circuits are field reviewed by the local arborist to determine actual growth conditions in the field and may be adjusted based on their findings. A review is also performed to ensure that work is done in both urban and rural areas. Feeders are reviewed not only across all of National Grid, but also on a State by State basis. Recent significant changes or new construction plans on a circuit are typical reasons for making adjustments in the work plan.

The Tree Model is also used to set the priorities for selecting circuits to include in the Enhanced Hazard Tree Mitigation Program as discussed in that section of this Strategy document. EHTM circuits are selected and ordered by Tree Model Rank.

3.0 Benefits

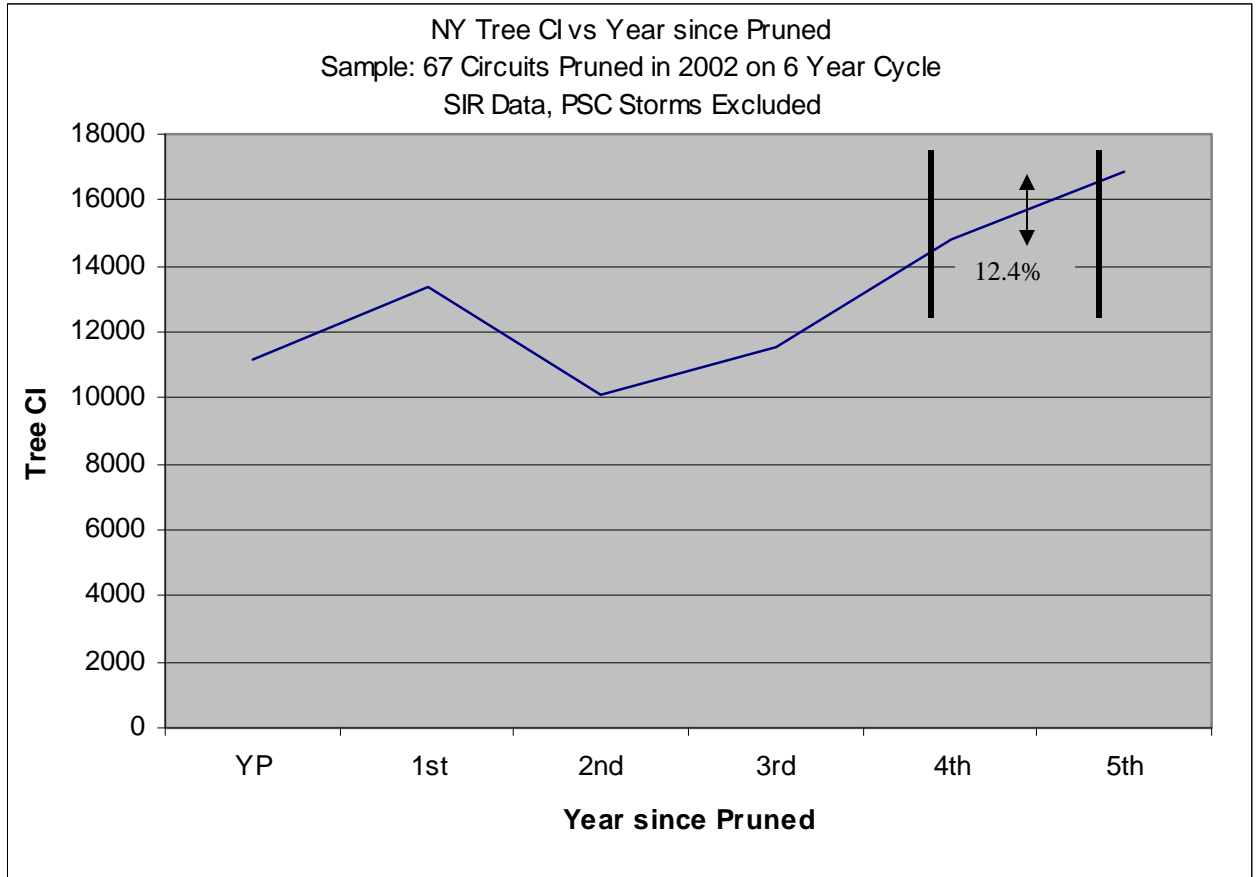
The principal benefits of the Cycle Pruning and Enhanced Hazard Trees are safety, reliability, regulatory and efficiency.

3.1 Safety & Environmental

Cycle pruning or keeping circuits on a consistent cycle pruning schedule will minimize the public safety risk presented when a tree makes contact with energized conductors through growth. When trees are allowed to grow into energized conductors there is the risk of electrocution through direct contact in a climbable tree or indirect contact through the tree itself. In addition, although not as serious in this climate, is the risk of fire in the tree or on the ground produced by electrical arcing through the vegetation when allowed to grow into and engulf the energized conductors. This strategy will minimize the potential for injury, property damage and liability regarding these identified risks.

3.2 Reliability

This cycle pruning work is expected to reduce the five-year average National Grid USA SAIFI by .0035 each year up to FY11. From that point on, cycle pruning will simply act to stabilize tree reliability performance while also providing a measure of public safety and efficiency for line and inspection crews. This annual improvement is based on the establishment of a pruning cycle in Massachusetts, Rhode Island and New Hampshire along with the reduction in the existing pruning cycle length in New York from 6 to 5 years as demonstrated in the graph below.



New England enhanced hazard tree projects have provided, on average, a 52% improvement in circuit tree SAIFI where performed. However, in NY where tree densities are less than half of New England tree densities, the average circuit tree SAIFI improvement is down to 24%. On a total annual basis, hazard tree work completed in Fiscal Year 2007 is expected to provide a SAIFI improvement in NY of 0.006, in Massachusetts of 0.018, in Rhode Island of 0.007 and in New Hampshire of 0.05.

3.3 Regulatory

This strategy is designed to improve National Grid's reliability performance as measured by state regulatory service quality targets. The overall goal is to meet state regulatory targets by 2008. Meeting our state regulatory service quality standards will eliminate financial penalties and improve our relationship with the regulators.

3.4 Customer

While this is not a customer focused strategy, customers on the feeders in the program will experience a significant reliability improvement. However, it should be recognized that there is a significant portion of the customer population that is often displeased with the pruning of their trees. Several public education programs are in place and will continue to be utilized.

3.5 Efficiency

Cycle pruning on an optimal schedule provides three measures of efficiency for National Grid.

First, studies done on optimal pruning cycles and the timing or deferment of pruning show a significant increase in cost in the first year past the optimum cycle length. One study shows that when tree growth actually grows through phases of overhead primary that the increased time required to safely prune and remove branches from around the energized conductors can raise the costs per mile by as much as 21%. By keeping cycle lengths and funding consistent, that parameter of the cost per mile for pruning will remain favorable for National Grid.

Secondly, the clearances created by the pruning program provide improved access to the overhead distribution assets for our maintenance crews for both routine day-to-day work as well as storm restoration work.

Lastly, the clearances created by the pruning program provide optimal visibility for our inspection crews allowing them to clearly see all features of the distribution assets which should improve overall inspection value as well as move through their circuit inspections in a timely manner.

4.0 **Estimated Costs**

Approximately 11,200 miles of overhead distribution must be pruned each year in order to stay on our prescribed cycle lengths by state. The program must continue into perpetuity. The average cost for circuit pruning across all four states is approximately \$3400 per mile, with 11,420 miles to do each year the total cost of cycle pruning is approximately \$38.8 million per year.

On-cycle enhanced hazard tree costs are budgeted based on the average number of three phase miles in a single year of pruning multiplied by the hazard tree cost per three phase mile as shown in Section 3.0. On average, 4500 miles of three-phase are incorporated into the on-cycle hazard tree program for a total cost of \$11.6 million per year. Off-cycle hazard tree work is budgeted based on historic need at approximately \$4.7 million per year.

5.0 Risk Assessment

The principal risks of the Cycle Pruning and Enhanced Hazard Tree Program are safety, reliability and regulatory.

5.1 Safety & Environmental

This strategy reduces the risk of public injury, property damage and liability risks as described in the benefit section of this strategy.

5.2 Reliability

Based on Reliability data the risk of tree related interruptions from grow-in conditions are significantly low (less than 10%) when all circuits are kept on their appropriate pruning schedule based on growing season and species composition. Cycle pruning should not be considered for any substantial increase in reliability performance once a full cycle has been implemented due to the fact that the vegetation surrounding the overhead conductors continues to grow. Each year only 20% of the overhead primary population is being pruned while growth is occurring on the other 80%. It is not a one time strategy but instead a continuing process. On the other hand, hazard tree failure constitutes more than 50% of our tree interruptions and as much as 95% when limb failures are included.

5.3 Regulatory

Maintaining a favorable working relationship with state regulators is key to the future success of National Grid. Continued poor performance against state regulatory service quality standards puts this relationship in jeopardy and results in financial penalties.

5.4 Customer

Continued poor reliability performance will be result in negative customer satisfaction and increased complaints to state regulators. A significant proportion of the population is often displeased by the appearance of pruned trees along municipal roadsides. In fact, in New England townships where tree work is governed by the Town Tree Warden there may be restrictions applied to National Grid's clearance requirements.

5.5 Efficiency

Efficiency losses will develop if vegetation is allowed to interfere with the overhead distribution assets as working around "grown-in" conditions will greatly slow routine line maintenance and storm restoration as well as deter accurate and efficient line inspections.

6.0 Data Requirements

The data necessary to manage the Cycle Pruning Strategy is currently available and a set of models has been developed to support the strategy. The main areas open for improvement are schedule and cost tracking for better reliability performance tracking of feeders after work has been completed.

6.1 Existing/Interim:

Excel – Existing Cycle Pruning Schedule data
Smallworld/ArcSDE – Feeder asset data
PowerOn/IDS/SIR – Feeder reliability data

6.2 Proposed:

An improved database application for tracking cycle pruning schedules, hazard tree completions, vendors, and costs using Access or Oracle which can be distributed over the network for update and reference by all Vegetation personnel as well as referenced by Reliability Engineering. In addition, provide the ability to analyze the vegetation management data as well as reliability performance data in a geospatial format.

6.3 Comments:

Improved data quality in both feeder asset and reliability areas will support the refinement of the modeling process.

7.0 Appendices

- 7.1 NY Pruning Specification
- 7.2 NE Pruning Specification
- 7.3 Enhanced Hazard Tree Specification